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Harashima

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(54) **CONTROL DEVICE, CONTROL METHOD, AND IMAGE FORMING APPARATUS**

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G03G 15/00 (2006.01)
G03G 15/01 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/5058*** (2013.01); ***G03G 15/0189*** (2013.01); *G03G 2215/0129* (2013.01); *G03G 2215/0164* (2013.01)

(58) **Field of Classification Search**
USPC 399/49
See application file for complete search history.

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(57) **ABSTRACT**

A control device includes an acquiring unit acquiring code image data expressing a code image having dots arranged in an array that expresses information; a generating unit extracting the dots from the code image and generating patch image data expressing patch images having the dots orderly arranged in different densities; an image-formation control unit controlling an image forming unit so as to form the patch images based on the patch image data in accordance with a preset image forming condition by using an invisible toner; a measuring unit measuring densities of the patch images; and a changing unit changing the image forming condition if at least one measured density is outside a density range set according to a corresponding dot density based on a correspondence relationship between the measured densities and densities of the dots, so that all of the measured densities are set within the corresponding density ranges.

15 Claims, 7 Drawing Sheets

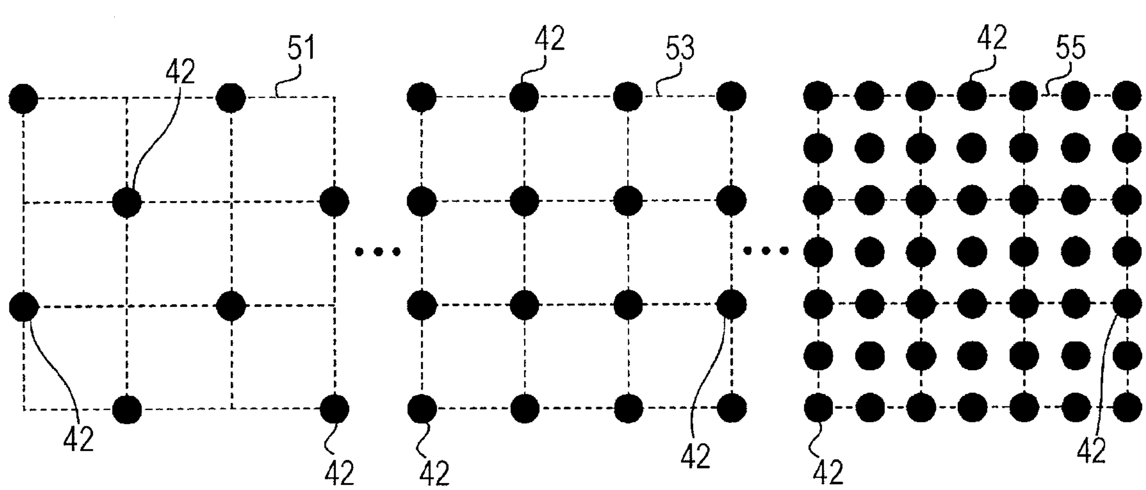


FIG. 1

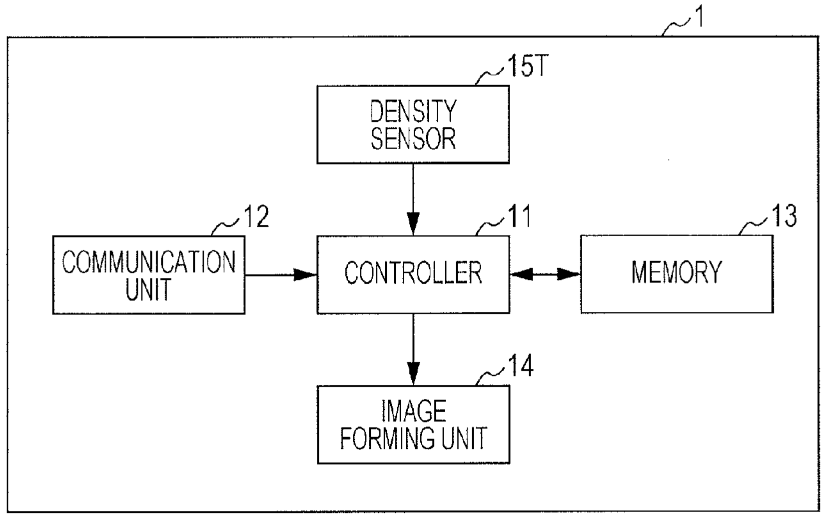

1
15T
DENSITY SENSOR
12
COMMUNICATION UNIT
11
CONTROLLER
13
MEMORY
14
IMAGE FORMING UNIT

FIG. 2

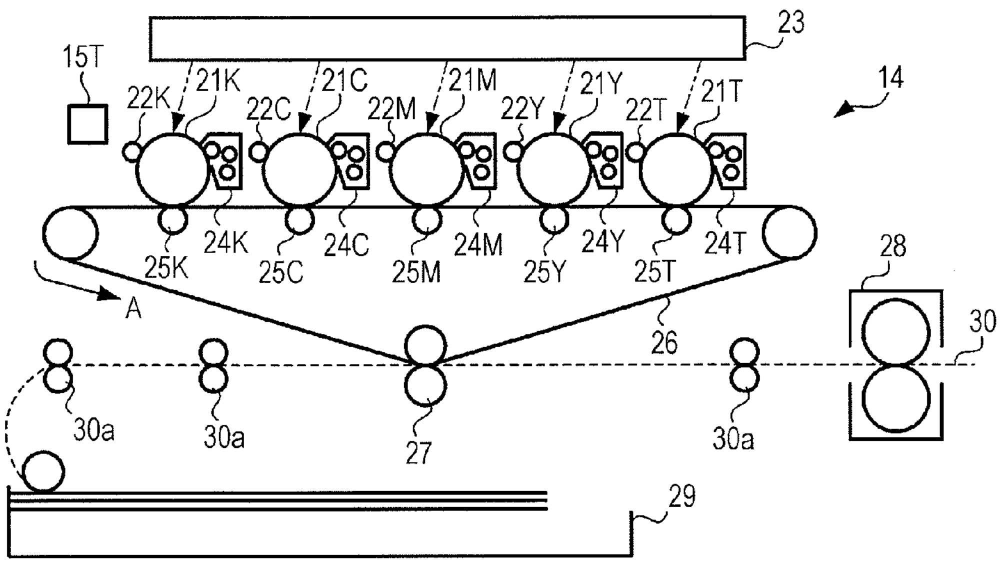

23
15T
22K
21K
22C
21C
22M
21M
22Y
21Y
22T
21T
14
24K
24C
24M
24Y
24T
25K
25C
25M
25Y
25T
28
A
26
30
30a
30a
27
30a
29

FIG. 3

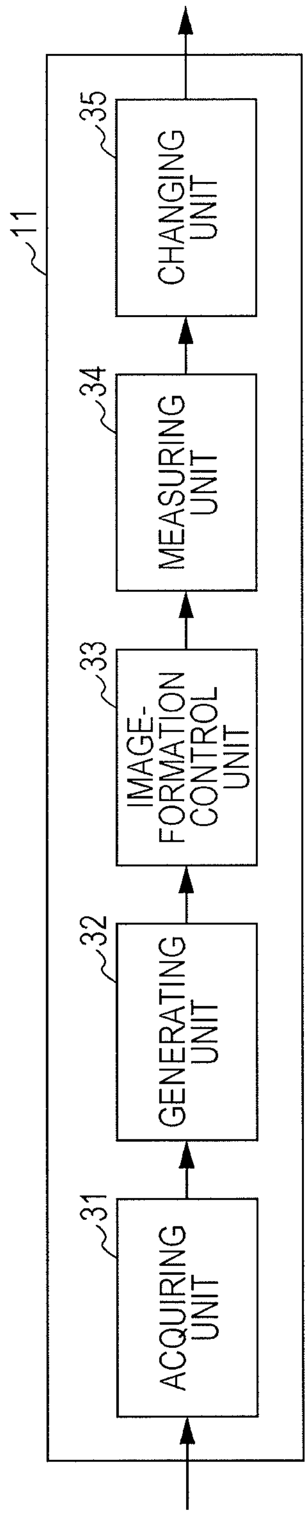

11
31
ACQUIRING UNIT
32
GENERATING UNIT
33
IMAGE-FORMATION CONTROL UNIT
34
MEASURING UNIT
35
CHANGING UNIT

FIG. 4

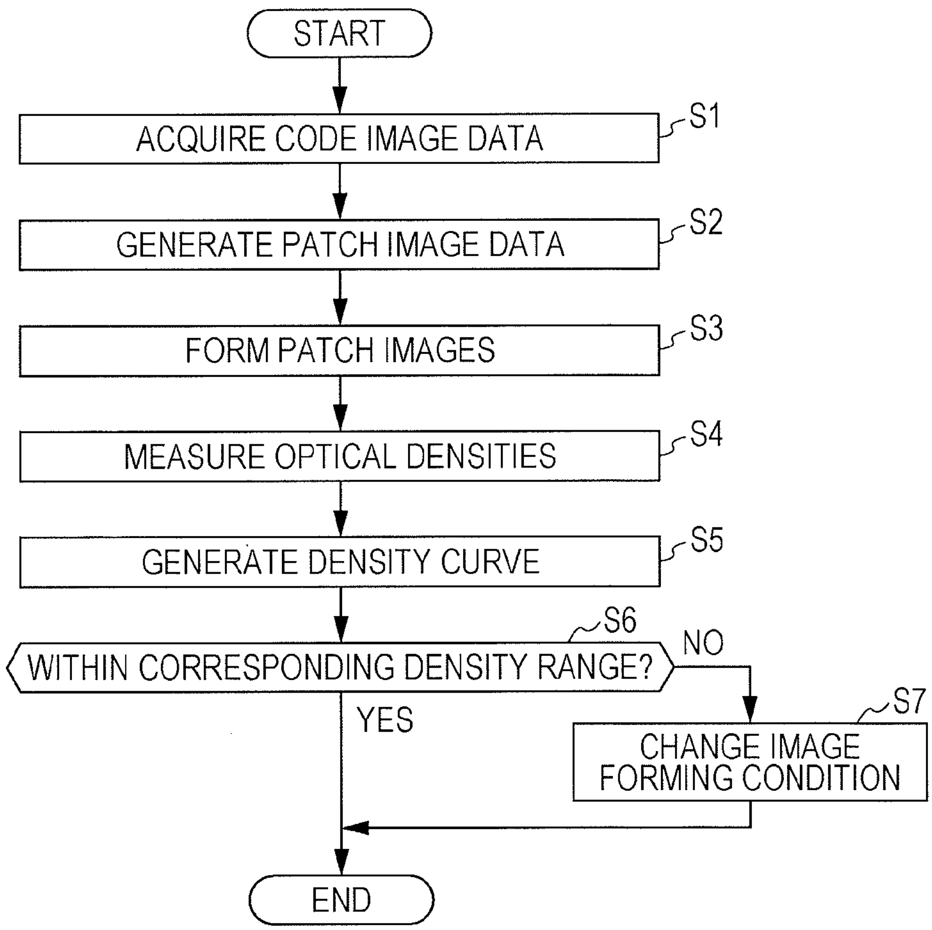

START
ACQUIRE CODE IMAGE DATA
S1
GENERATE PATCH IMAGE DATA
S2
FORM PATCH IMAGES
S3
MEASURE OPTICAL DENSITIES
S4
GENERATE DENSITY CURVE
S5
WITHIN CORRESPONDING DENSITY RANGE?
S6
NO
YES
CHANGE IMAGE FORMING CONDITION
S7
END

FIG. 5

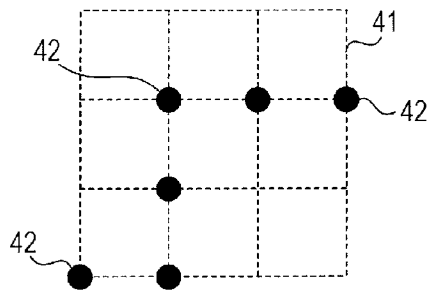


FIG. 6

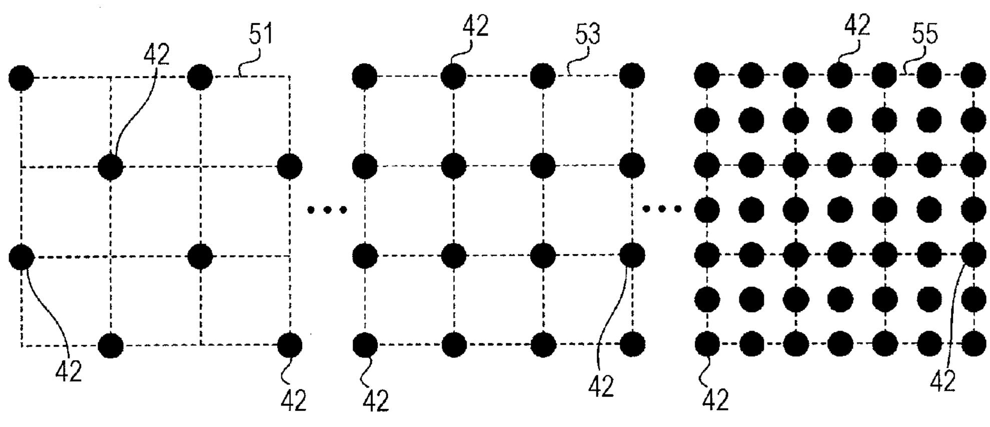


FIG. 7

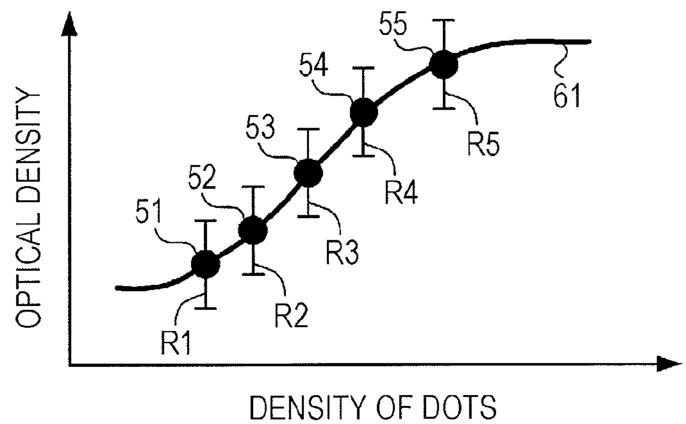

55
54
53
52
51
61
R5
R4
R3
R2
R1
OPTICAL DENSITY
DENSITY OF DOTS

FIG. 8

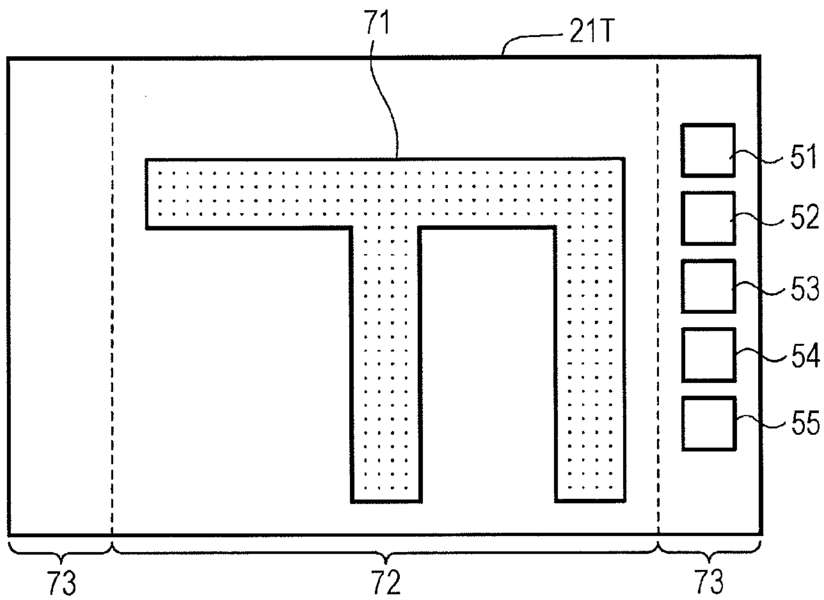

71
21T
51
52
53
54
55
73
72
73

FIG. 9

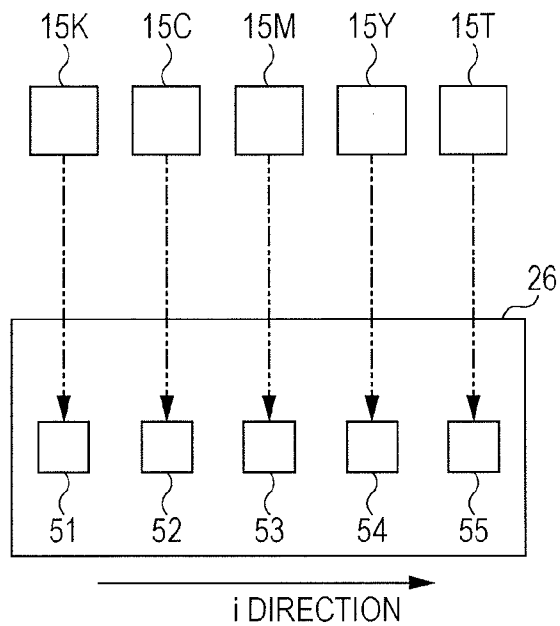

15K
15C
15M
15Y
15T
26
51
52
53
54
55
i DIRECTION

FIG. 10

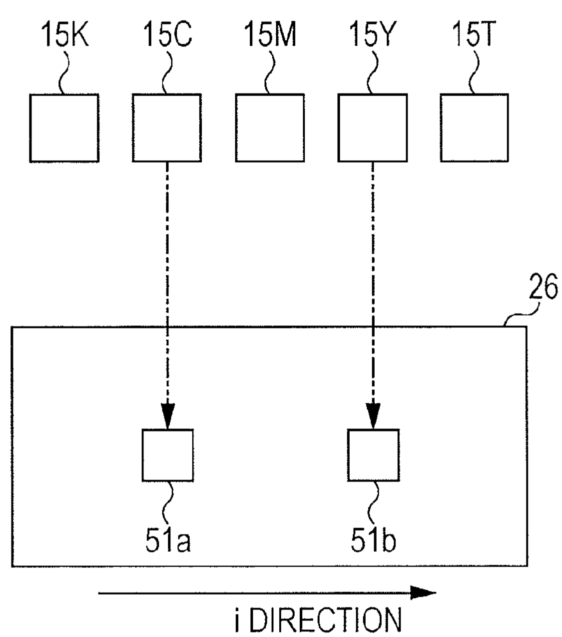
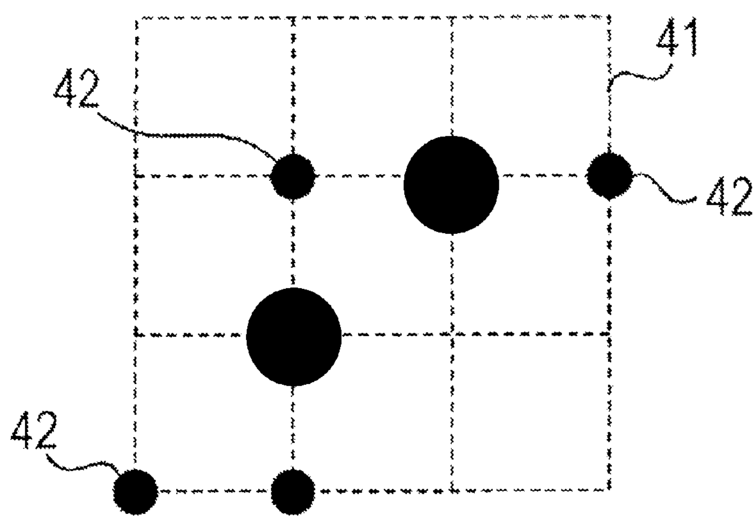

15K
15C
15M
15Y
15T
26
51a
51b
i DIRECTION

FIG. 11



CONTROL DEVICE, CONTROL METHOD, AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2011-036899 filed Feb. 23, 2011.

BACKGROUND

Technical Field

The present invention relates to control devices, control methods, and image forming apparatuses.

SUMMARY

According to an aspect of the invention, there is provided a control device including an acquiring unit, a generating unit, an image-formation control unit, a measuring unit, and a changing unit. The acquiring unit acquires code image data expressing a code image having dots that are arranged in an array that expresses information. The generating unit extracts the dots from the code image expressed by the acquired code image data and generates patch image data expressing multiple patch images in which the extracted dots are orderly arranged in different densities. The image-formation control unit controls an image forming unit so that the image forming unit forms the multiple patch images on the basis of the generated patch image data in accordance with a preset image forming condition by using an invisible toner that absorbs infrared light or ultraviolet light. The measuring unit measures densities of the multiple patch images formed by the image forming unit. Based on a correspondence relationship between the densities of the multiple patch images measured by the measuring unit and densities of the dots in the multiple patch images, if at least one of the measured densities is outside a density range set in accordance with the density of the corresponding dots, the changing unit changes the image forming condition so that all of the measured densities are set within corresponding density ranges set in accordance with the densities of the corresponding dots.

BRIEF DESCRIPTION OF THE DRAWINGS

An exemplary embodiment of the present invention will be described in detail based on the following figures, wherein:

FIG. **1** illustrates the configuration of an image forming apparatus;

FIG. **2** illustrates the configuration of an image forming unit;

FIG. **3** illustrates a functional configuration of a controller and a density sensor;

FIG. **4** is a flowchart illustrating a process for adjusting an image forming condition;

FIG. **5** illustrates an example of a code image;

FIG. **6** illustrates an example of patch images;

FIG. **7** illustrates an example of a density curve;

FIG. **8** illustrates an example of patch images formed in accordance with a modification;

FIG. **9** illustrates an example of patch images formed in accordance with another modification;

FIG. **10** illustrates an example of patch images formed in accordance with yet another modification; and

FIG. **11** illustrates an example of a coded image having different sized dots.

DETAILED DESCRIPTION

FIG. **1** illustrates the configuration of an image forming apparatus **1** according to an exemplary embodiment of the invention. The image forming apparatus **1** includes a controller **11**, a communication unit **12**, a memory **13**, an image forming unit **14**, and a density sensor **15**T. The controller **11** includes a central processing unit (CPU) and a memory. The CPU executes a program stored in the memory so as to control each component in the image forming apparatus **1**. The communication unit **12** performs communication with a terminal apparatus (not shown) via a communication line. The memory **13** includes, for example, a hard disk and stores various kinds of data.

FIG. **2** illustrates the configuration of the image forming unit **14**. The image forming unit **14** includes photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T. Each of the photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T has a photosensitive layer and rotates about a shaft. The photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T are respectively surrounded by chargers **22**Y, **22**M, **22**C, **22**K, and **22**T, an exposure device **23**, developing devices **24**Y, **24**M, **24**C, **24**K, and **24**T, and first-transfer rollers **25**Y, **25**M, **25**C, **25**K, and **25**T.

The chargers **22**Y, **22**M, **22**C, **22**K, and **22**T uniformly electrostatically-charge the surfaces of the photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T, respectively. The exposure device **23** exposes the electrostatically-charged photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T to light so as to form electrostatic latent images thereon. Based on preset development potential, the developing devices **24**Y, **24**M, **24**C, **24**K, and **24**T develop the electrostatic latent images formed on the photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T by using toner so as to form toner images. The developing devices **24**Y, **24**M, **24**C, and **24**K respectively accommodate yellow, magenta, cyan, and black toners and use the respective toners to perform the developing process. The developing device **24**T accommodates an invisible toner and uses the invisible toner to perform the developing process. This invisible toner is substantially transparent relative to visible light and absorbs infrared light or ultraviolet light. Since such an invisible toner absorbs a small amount of visible light, the toner readily becomes visually recognizable as the amount of toner increases. The term "invisible" refers to a state in which an object is difficult to visually recognize, regardless of whether the object is visually recognizable in actuality.

Based on preset first transfer bias, the first-transfer rollers **25**Y, **25**M, **25**C, **25**K, and **25**T transfer the toner images formed on the photoconductor drums **21**Y, **21**M, **21**C, **21**K, and **21**T onto an intermediate transfer belt **26**. The intermediate transfer belt **26** rotates in a direction indicated by an arrow A in FIG. **2** so as to transport the toner images transferred thereto by the first-transfer rollers **25**Y, **25**M, **25**C, **25**K, and **25**T to a second-transfer roller **27**. The second-transfer roller **27** transfers the toner images transported thereto by the intermediate transfer belt **26** to a recording medium. This recording medium is, for example, a sheet of paper. A fixing unit **28** fixes the toner images onto the recording medium by applying heat and pressure thereto. A feeding unit **29** accommodates multiple recording media and feeds the accommodated recording media in a one-by-one manner. A transport unit **30** has multiple transport rollers **30**a and transports each recording medium fed from the feeding unit **29** to an outlet via the second-transfer roller **27** and the fixing unit **28**.

As shown in FIG. **2**, the density sensor **15**T is provided above the intermediate transfer belt **26**. The density sensor **15**T emits light to an invisible toner image on the intermediate transfer belt **26** and detects reflected light thereof so as to measure the optical density of the invisible toner image.

FIG. **3** illustrates a functional configuration of the controller **11** and the density sensor **15**T. An acquiring unit **31**, a generating unit **32**, an image-formation control unit **33**, and a changing unit **35** are implemented by the controller **11**. A measuring unit **34** is implemented by the density sensor **15**T. The acquiring unit **31** acquires code image data expressing a code image having dots that are arranged in an array that expresses information. The generating unit **32** extracts the dots from the code image expressed by the code image data acquired by the acquiring unit **31** and generates patch image data expressing multiple patch images in which the extracted dots are orderly arranged in different densities. Based on the patch image data generated by the generating unit **32**, the image-formation control unit **33** controls the image forming unit **14** so that the image forming unit **14** forms the multiple patch images in accordance with a preset image forming condition by using the invisible toner. The measuring unit **34** measures the densities of the multiple patch images formed by the image forming unit **14**. Based on a correspondence relationship between the densities of the patch images measured by the measuring unit **34** and the densities of the dots in the corresponding patch images, if at least one of the densities measured by the measuring unit **34** is outside a density range set in accordance with the density of the corresponding dots, the changing unit **35** changes the image forming condition of the image forming unit **14** so that all of the densities measured by the measuring unit **34** are set within corresponding density ranges set in accordance with the densities of the corresponding dots.

When the image forming apparatus **1** receives a command for forming a code image **41**, the image forming apparatus **1** performs a process for adjusting the image forming condition before forming the code image **41**. The code image **41** expresses specific information based on an array of dots formed using the invisible toner. FIG. **4** is a flowchart illustrating the process for adjusting the image forming condition. In step S**1**, the controller **11** acquires code image data expressing the code image **41**. For example, the controller **11** receives code image data transmitted from the terminal apparatus (not shown) via the communication unit **12**. FIG. **5** illustrates an example of the code image **41**. In the code image **41**, six dots **42** are arranged in an array that expresses specific information. The dots **42** constituting the code image **41** all have the same size. The grid lines shown in FIG. **5** are imaginary lines and are not drawn in actuality.

In step S**2**, the controller **11** extracts the dots **42** from the code image **41** expressed by the acquired code image data. Then, the controller **11** generates patch image data expressing patch images **51** to **55** in which the extracted dots **42** are orderly arranged in different densities. FIG. **6** illustrates an example of the patch images **51** to **55**. The patch images **51** to **55** have the same size. However, the patch images **51** to **55** have different numbers of dots **42** disposed therein. For example, the patch image **51** has eight dots **42** disposed therein. The patch image **53** has **16** dots **42** disposed therein. The patch image **55** has **49** dots **42** disposed therein. In this case, the density of the dots **42** is at a minimum in the patch image **51**, and increases in the following order: the patch image **52**, the patch image **53**, the patch image **54**, and the patch image **55**. The number and the array of dots **42** in each of the patch images **51** to **55** are set in advance. Similar to FIG. **5**, the grid lines shown in FIG. **6** are imaginary lines and are not drawn in actuality.

In step S**3**, the controller **11** supplies the generated patch image data to the image forming unit **14**. Then, the controller **11** controls the image forming unit **14** so that the image forming unit **14** forms the patch images **51** to **55** in accordance with a present image forming condition by using the invisible toner. Under the control of the controller **11**, the image forming unit **14** forms the patch images **51** to **55**. Specifically, based on the patch image data supplied from the controller **11**, the exposure device **23** exposes the photoconductor drum **21**T, which is electrostatically charged, to light so as to form an electrostatic latent image thereon. With preset development potential, the developing device **24**T develops the electrostatic latent image formed on the photoconductor drum **21**T by using the invisible toner, thereby forming the patch images **51** to **55**. Based on preset first transfer bias, the first-transfer roller **25**T transfers the patch images **51** to **55** formed on the photoconductor drum **21**T onto the intermediate transfer belt **26**.

In step S**4**, the density sensor **15**T measures the optical densities of the patch images **51** to **55** on the intermediate transfer belt **26**. In step S**5**, the controller **11** generates a density curve **61** on the basis of the optical densities measured by the density sensor **15**T. FIG. **7** illustrates an example of the density curve **61**. The density curve **61** indicates a correspondence relationship between the densities of the dots **42** in the patch images **51** to **55** and the optical densities of the patch images **51** to **55**. The densities of the dots **42** in the patch images **51** to **55** are stored in a memory when, for example, generating the patch image data.

In step S**6**, the controller **11** determines whether or not the optical densities of the patch images **51** to **55** are within corresponding density ranges R**1** to R**5**. The density ranges R**1** to R**5** are respectively set in accordance with the densities of the dots **42** in the patch images **51** to **55**, respectively. For example, each of the density ranges R**1** to R**5** is an optical-density range in which, when the corresponding dots **42** are arranged in the same density as the corresponding patch image **51** to **55** and are formed of the invisible toner, the aforementioned dots **42** can be accurately read by a scanner that emits infrared light or ultraviolet light. If the optical densities of the patch images **51** to **55** are within the corresponding density ranges R**1** to R**5** (YES in step S**6**), the controller **11** ends the process without changing the image forming condition. In contrast, if at least one of the optical densities of the patch images **51** to **55** is outside the corresponding density range (NO in step S**6**), the controller **11** proceeds to step S**7**.

In step S**7**, the controller **11** changes the image forming condition so that the optical densities of the patch images **51** to **55** are set within the corresponding density ranges R**1** to R**5**. Specifically, if the optical density of a patch image is greater the corresponding density range, the controller **11** changes the image forming condition so that the amount of invisible toner is reduced. If the optical density of the patch image is smaller than the corresponding density range, the controller **11** changes the image forming condition so that the amount of invisible toner is increased. The image forming condition to be changed in this case is, for example, the amount of invisible toner in the developing device **24**T (an example of a developing condition), the development potential of the developing device **24**T (an example of a developing condition), or the first transfer bias of the first-transfer roller **25**T (an example of a transfer condition). For example, in the case where the amount of invisible toner in the developing device **24**T is to be changed, the amount of invisible toner in the developing device **24**T is reduced if the optical density of the patch image is greater than the corresponding density range, whereas the amount of invisible toner in the developing device **24**T is increased if the optical density of the patch image is smaller than the corresponding density range. In the case where the development potential is to be changed, the development potential is reduced if the optical density of the patch image is greater than the corresponding density range, whereas the development potential is increased if the optical density of the patch image is smaller than the corresponding density range.

Upon completion of the process shown in FIG. **4**, the image forming apparatus **1** forms the code image **41** on a recording medium. If the image forming condition is changed in step S**7**, the code image **41** is formed in accordance with the changed image forming condition. Consequently, the code image **41** is formed using an appropriate amount of invisible toner. When the code image **41** is formed using an appropriate amount of invisible toner in this manner, the code image **41** is difficult to visually recognize. Furthermore, the code image **41** formed on the recording medium is read by a reading device, such as a scanner that emits infrared light or ultraviolet light. Accordingly, the specific information expressed by the array of dots **42** is recognized. As mentioned above, the code image **41** is formed of an appropriate amount of invisible toner. Therefore, when the code image **41** is to be read by the reading device, the dots **42** included in the code image **41** are accurately read. This improves the reliability of reading the code image **41**.

The present invention is not limited to the exemplary embodiment described above, and modifications are permissible as follows. The following modifications may also be combined with each other.

First Modification

The determination process in step S**6** may be performed using only the optical densities of patch images located in the central region of the density curve **61**. This is due to the fact that the sensitivity of the optical densities of the patch images located in the central region of the density curve **61** is higher than that of the optical densities of the patch images located at the ends of the density curve **61**. For example, in the density curve **61** shown in FIG. **7**, only the optical densities of the patch images **52** to **54** are used, whereas the optical densities of the patch image **51** with the minimum density of dots **42** and the patch image **55** with the maximum density of dots **42** are not used. In this case, the controller **11** changes the image forming condition if at least one of the optical densities of the patch images **52** to **54** is outside the corresponding density range. In contrast, when the optical densities of the patch images **52** to **54** are within the corresponding density ranges R**2** to R**4**, the controller **11** does not change the image forming condition even if the optical density of the patch image **51** or **55** is outside the corresponding density range.

In this modification, not all of the optical densities of the patch images **52** to **54** need to be used. For example, only the optical density of the patch image **52** and the optical density of the patch image **54** may be used. In other words, among the patch images **51** to **55**, the controller **11** may perform the determination process in step S**6** by using some of or all of the patch images excluding the patch image **51** with the minimum density of dots **42** and the patch image **55** with the maximum density of dots **42**.

Second Modification

When forming a color image, the image forming apparatus **1** may form the patch images **51** to **55** in addition to the color image. In this case, the color image is an image other than the code image **41**. The color image is formed using, for example, at least one of yellow, magenta, cyan, and black toners. FIG. **8** illustrates an example of the patch images **51** to **55** formed in accordance with this modification. When a color image **71** is to be formed by the image forming unit **14**, the controller **11** controls the image forming unit **14** so that the image forming unit **14** forms the color image **71** in an image region **72** (an example of a first region) and the patch images **51** to **55** in a non-image region **73** (an example of a second region). Under the control of the controller **11**, the image forming unit **14** forms the color image **71** in the image region **72** and the patch images **51** to **55** in the non-image region **73**. The non-image region **73** corresponds to a region in the photoconductor drum **21**T that is not used for forming the color image **71**. The non-image region **73** corresponds to, for example, an end of the photoconductor drum **21**T. If color images **71** are to be continuously formed, the non-image region **73** may be a region between image regions **72** in which the color images **71** are formed.

Third Modification

In addition to the density sensor **15**T, the image forming apparatus **1** may include density sensors **15**Y, **15**M, **15**C, and **15**K. When a color image is to be formed, the density sensors **15**Y, **15**M, **15**C, and **15**K measure the densities of a yellow image, a magenta image, a cyan image, and a black image, respectively. When the patch images **51** to **55** are to be formed, the density sensors **15**Y, **15**M, **15**C, and **15**K measure the optical densities of the patch images **51** to **55** together with the density sensor **15**T. The density sensors **15**Y, **15**M, **15**C, and **15**K are provided above the intermediate transfer belt **26**. The density sensors **15**Y, **15**M, **15**C, **15**K, and **15**T are arranged in the width direction of the intermediate transfer belt **26**.

FIG. **9** illustrates an example of the patch images **51** to **55** formed in accordance with this modification. The controller **11** generates patch image data expressing the patch images **51** to **55** arranged in an i direction. The i direction corresponds to an axial direction of the photoconductor drum **21**T (i.e., a main scanning direction of the exposure device **23**). In this case, the image forming unit **14** forms the patch images **51** to **55** arranged in the main scanning direction by using the invisible toner. In the case where the patch images **51** to **55** are arranged in the main scanning direction in this manner, the time required for the exposure and development processes is shortened, as compared with a case where the patch images **51** to **55** are arranged in the sub scanning direction. Subsequently, the patch images **51** to **55** are transferred onto the intermediate transfer belt **26**. In this case, the patch images **51** to **55** are arranged in the width direction of the intermediate transfer belt **26**. Specifically, the i direction in which the patch images **51** to **55** are arranged corresponds to the width direction of the intermediate transfer belt **26**. As shown in FIG. **9**, the density sensors **15**K, **15**C, **15**M, **15**Y, and **15**T measure the optical densities of the patch images **51** to **55**, respectively. Because the patch images **51** to **55** and the density sensors **15**K, **15**C, **15**M, **15**Y, and **15**T are both arranged in the width direction of the intermediate transfer belt **26**, the optical densities of the patch images **51** to **55** are measured substantially at the same time.

Fourth Modification

If the image forming apparatus **1** includes multiple density sensors as in the third modification, multiple identical patch images may be formed for correcting in-plane unevenness. This in-plane unevenness occurs when the image density is uneven within the same plane of a recording medium. FIG. **10** illustrates an example of patch images **51***a* and **51***b* formed in accordance with this modification. The controller **11** generates patch image data expressing the patch images **51***a* and **51***b* arranged in the i direction. The i direction corresponds to the main scanning direction of the exposure device **23** (i.e., the axial direction of the photoconductor drum **21**T). The patch images **51***a* and **51***b* are constituted of identical dots **42** and have identical dot densities. In this case, the image forming unit **14** forms the patch images **51***a* and **51***b* arranged in the main scanning direction by using the invisible toner. Subsequently, the patch images **51***a* and **51***b* are transferred onto the intermediate transfer belt **26**. In this case, the patch images **51***a* and **51***b* are arranged in the width direction of the intermediate transfer belt **26**. Specifically, the i direction in which the patch images **51***a* and **51***b* are arranged corresponds to the width direction of the intermediate transfer belt **26**. As shown in FIG. **10**, the density sensors **15**C and **15**Y measure the optical densities of the patch images **51***a* and **51***b*, respectively.

After the optical densities of the patch images **51***a* and **51***b* are respectively measured by the density sensors **15**C and **15**Y, the controller **11** compares the optical density of the patch image **51***a* and the optical density of the patch image **51***b* with each other. If the optical densities are different, the controller **11** changes the image forming condition so as to reduce the density difference therebetween. The image forming condition to be changed in this case is, for example, the development potential. For example, if the optical density of the patch image **51***a* is greater than the optical density of the patch image **51***b*, the development potential for a region in which the patch image **51***a* is formed is reduced, whereas the development potential for a region in which the patch image **51***b* is formed is increased.

In this modification, the image forming apparatus **1** may form a patch image that includes multiple regions arranged in the i direction. In this case, the density sensors **15**C and **15**Y measure the optical densities of different regions in the patch image. The controller **11** compares the optical densities of the multiple regions in the patch image. If the optical densities are different, the controller **11** changes the image forming condition so as to reduce the density difference therebetween.

Fifth Modification

As shown in FIG. **11**, the code image **41** may be constituted of multiple dots having different sizes. For example, if the code image **41** is constituted of large dots and small dots, the controller **11** extracts the large dots and the small dots from the code image **41**. Then, the controller **11** generates first patch image data expressing multiple patch images in which the large dots are arranged, and second patch image data expressing multiple patch images in which the small dots are arranged. In this case, the controller **11** performs step S3 and onward for each generated patch image data.

Sixth Modification

The image forming apparatus **1** may form a color patch image. This color patch image is formed, for example, with a predetermined gradation by using yellow, magenta, cyan, and black toners. In this case, the controller **11** may form the patch images **51** to **55** more frequently than the color patch image.

Seventh Modification

The number of patch images is not limited to five, and may be five or more. Moreover, the number of dots **42** and the array of dots **42** in each patch image are not limited to those in the example shown in FIG. **6**. The number of dots **42** is not limited so long as the densities of dots **42** differ among multiple patch images. Furthermore, the array of dots **42** is not limited so long as the dots **42** are orderly arranged.

Eighth Modification

In the exemplary embodiment, the image forming condition is changed if at least one of the optical densities of the patch images **51** to **55** is outside the corresponding density range. However, if the number of optical densities outside the corresponding density ranges is equal to or smaller than a threshold value, the image forming condition may be left unchanged. For example, if there is only one optical density that is outside the corresponding density range, the image forming condition may be determined as being substantially acceptable, and the image forming condition may thus be left unchanged.

Ninth Modification

The image forming condition may be a parameter other than the amount of invisible toner in the developing device **24**T, the development potential, and the first transfer bias so long as the parameter is used for controlling the amount of invisible toner for forming the code image **41**.

Tenth Modification

The controller **11** may include an application specific integrated circuit (ASIC). In this case, the function of the controller **11** may be achieved by the ASIC alone or by both the ASIC and the CPU. Furthermore, the controller **11** and the density sensor **15**T may be provided as a control device.

Eleventh Modification

The program for achieving the function of the controller **11** may be stored in a computer-readable storage medium, such as a magnetic storage medium (e.g., a magnetic tape, a magnetic disk (hard disk drive (HDD), flexible disk (FD)), etc.), an optical storage medium (e.g., an optical disk (compact disc (CD), digital versatile disk (DVD)), etc.), a magneto-optical storage medium, or a semiconductor memory, and may be installed in the image forming apparatus **1**. Alternatively, the program may be installed by being downloaded via a communication line.

The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A control device comprising:

an acquiring unit that acquires code image data expressing a code image having dots that form a dot pattern such that information is embedded;

a generating unit that extracts the dots from the code image expressed by the acquired code image data, and generates patch image data expressing a plurality of patch images in which the extracted dots are orderly arranged in different densities;

an image-formation control unit that controls an image forming unit to form the plurality of patch images on the basis of the generated patch image data in accordance with a preset image forming condition by using an invisible toner that absorbs infrared light or ultraviolet light;

a measuring unit that measures densities of the plurality of patch images formed by the image forming unit; and

a changing unit that changes the image forming condition in response to at least one of the measured densities being outside of a density range that is set in accordance with a density of the corresponding dots based on a correspondence relationship between the measured densities and densities of the dots in the plurality of patch images, so that all of the measured densities are set within corresponding density ranges set in accordance with the densities of the corresponding dots.

2. The control device according to claim **1**, wherein the image forming unit includes:

a charging section that electrostatically charges an image bearing member;

an exposure section that exposes the electrostatically-charged image bearing member to light so as to form a latent image thereon, a developing section that develops the formed latent image by using the invisible toner so as to form a toner image; and

a transfer section that transfers the formed toner image from the image bearing member to a transfer medium; and

wherein the image forming condition includes a developing condition of the developing section or a transfer condition of the transfer section.

3. The control device according to claim **2**, wherein the plurality of patch images include a first patch image with a minimum density of the dots, a second patch image with a maximum density of the dots, and a third patch image other than the first and second patch images, and

wherein the changing unit changes the image forming condition in response to the density of the third patch image being outside the corresponding density range set in accordance with the density of the corresponding dots.

4. The control device according to claim **3**, wherein the measuring unit includes a plurality of measuring units,

wherein the image forming unit includes the image bearing member that rotates about an axis and has the plurality of patch images formed on a surface thereof,

wherein the generating unit generates the patch image data that expresses the plurality of patch images arranged in an axial direction of the image bearing member, and

wherein the plurality of measuring units measure the densities of the patch images, which are different from each other.

5. The control device according to claim **2**, wherein the measuring unit includes a plurality of measuring units,

wherein the image forming unit includes the image bearing member that rotates about an axis and has the plurality of patch images formed on a surface thereof,

wherein the generating unit generates the patch image data that expresses the plurality of patch images arranged in an axial direction of the image bearing member, and

wherein the plurality of measuring units measure the densities of the patch images, which are different from each other.

6. The control device according to claim **2**, wherein one of the patch images includes a plurality of regions arranged in a main scanning direction of the exposure section,

wherein the measuring unit measures densities of the plurality of regions included in the patch image, and

wherein in response to the densities of the plurality of regions measured by the measuring unit being different from each other, the changing unit changes the developing condition of the developing section so as to reduce the difference in the densities.

7. The control device according to claim **1**, wherein the plurality of patch images include a first patch image with a minimum density of the dots, a second patch image with a maximum density of the dots, and a third patch image other than the first and second patch images, and

wherein the changing unit changes the image forming condition in response to the density of the third patch image being outside the corresponding density range set in accordance with the density of the corresponding dots.

8. The control device according to claim **7**, wherein the measuring unit includes a plurality of measuring units,

wherein the image forming unit includes an image bearing member that rotates about an axis and has the plurality of patch images formed on a surface thereof,

wherein the generating unit generates the patch image data that expresses the plurality of patch images arranged in an axial direction of the image bearing member, and

wherein the plurality of measuring units measure the densities of the patch images, which are different from each other.

9. The control device according to claim **1**, wherein the measuring unit includes a plurality of measuring units,

wherein the image forming unit includes an image bearing member that rotates about an axis and has the plurality of patch images formed on a surface thereof,

wherein the generating unit generates the patch image data that expresses the plurality of patch images arranged in an axial direction of the image bearing member, and

wherein the plurality of measuring units measure the densities of the patch images, which are different from each other.

10. The control device according to claim **1**, wherein the image forming unit forms a color image other than the code image, and

wherein when the color image is to be formed by the image forming unit, the image-formation control unit controls the image forming unit so that the image forming unit forms the color image in a first region and the plurality of patch images in a second region that is not used for forming the color image.

11. The control device according to claim **1**, wherein in response to the dots in the code image including first dots and second dots having different sizes, the generating unit extracts the first dots and the second dots and generates first patch image data expressing a plurality of patch images in which the first dots are orderly arranged in different densities and second patch image data expressing a plurality of patch images in which the second dots are orderly arranged in different densities.

12. An image forming apparatus comprising:

the control device according to claim **1**; and

the image forming unit that forms the plurality of patch images under the control of the image-formation control unit on the basis of the generated patch image data in accordance with the preset image forming condition by using the invisible toner that absorbs infrared light or ultraviolet light.

13. The control device according to claim **1**, wherein the extracted dots are orderly arranged in a grid.

14. The control device according to claim **1**, wherein the code image includes first dots and second dots that have different sizes.

15. A control method comprising:

acquiring code image data expressing a code image having dots that form a dot pattern such that information is embedded;

extracting the dots from the code image expressed by the acquired code image data;

generating patch image data expressing a plurality of patch images in which the extracted dots are orderly arranged in different densities;
controlling an image forming unit to form the plurality of patch images on the basis of the generated patch image data in accordance with a preset image forming condition by using an invisible toner that absorbs infrared light or ultraviolet light;
measuring densities of the plurality of patch images formed by the image forming unit; and
changing the image forming condition in response to at least one of the measured densities of the plurality of patch images being outside a density range that is set in accordance with a density of the corresponding dots based on a correspondence relationship between the measured densities and densities of the dots in the plurality of patch images, so that all of the measured densities are set within corresponding density ranges set in accordance with the densities of the corresponding dots.

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